Ten-Year Changes in Smoking Among Young Adults: Are Racial Differences Explained by Socioeconomic Factors in the CARDIA Study?

Catarina I. Kiefe, PhD, MD, O. Dale Williams, PhD, Cora E. Lewis, MD, MSPH, Jeroan J. Allison, MD, MS, Padmini Sekar, MS, and Lynne E. Wagenknecht, DrPH

A B S T R A C T

Objectives. This study investigated whether socioeconomic factors explain racial/ethnic differences in regular smoking initiation and cessation.

Methods. Data were derived from the CARDIA study, a cohort of 5115 healthy adults aged 18 to 30 years at baseline (1985–1986) and recruited from the populations of 4 US cities. Respondents were followed over 10 years.

Results. Among 3950 respondents reexamined in 1995–1996, 20% of Whites and 33% of African Americans were smokers, as compared with 25% and 32%, respectively, in 1985–1986. On average, African Americans were of lower socioeconomic status. Ten-year regular smoking initiation rates for African American women, White women, African American men, and White men were 7.1%, 3.5%, 13.2%, and 5.1%, respectively, and the corresponding cessation rates were 25%, 35.1%, 19.2%, and 31.3%. After adjustment for socioeconomic factors, most 95% confidence intervals of the odds ratios for regular smoking initiation and cessation in African Americans vs Whites included 1.

Conclusions. Less beneficial 10-year changes in smoking were observed in African Americans, but socioeconomic factors explained most of the racial disparity. (*Am J Public Health.* 2001;91:213–218)

Tobacco smoking is a powerful and preventable risk factor for cardiovascular disease and also markedly increases the risk of lung, oropharyngeal, and esophageal cancers; chronic obstructive pulmonary disease; peptic ulcer disease; and osteoporosis, among others.[1] A recent National Institutes of Health task force report noted that "elimination of cigarette smoking is potentially one of the most important public health interventions that can be undertaken."[2(p2)]

The prevalence of cigarette smoking has decreased markedly in the United States over the past 3 decades,[3] although recent data suggest a leveling off.[3–5] Overall decreases have not been uniform across sociodemographic groups.[6] For example, women have lagged behind men, first in the increases observed before the 1960s and then in subsequent decreases through the mid-1980s,[3,7–9] and recent evidence no longer shows sex differences in rates of cessation.[10] Of concern, very recent data show a marked increase in smoking prevalence and initiation among adolescents.[11–13]

In comparison with reference populations generally described as White,[14] African Americans are known to have had higher rates of tobacco smoking for several decades.[3] It is also known that low income and low educational attainment are strongly associated with higher smoking rates[3,15] and that race/ethnicity and socioeconomic status (SES) are closely related in the United States. Hence, racial comparisons of smoking behavior in the United States are confounded by socioeconomic factors.

Are racial differences in smoking entirely attributable to the environment, including socioeconomic factors? Or are there genetic differences in, for example, predisposition to nicotine addiction[16] or metabolism[17,18] that contribute to the observed racial differences? Competing hypotheses for racial/ethnic differences in smoking behavior focus on genetic, socioeconomic, cultural, or behavioral explanations. We chose to investigate the role of socioeconomic factors in explaining racial differences.

We used a population-based longitudinal study of African American and White young adults in 4 US cities to (1) compare regular smoking prevalence, cessation, and initiation rates in African American and White young adults over a 10-year period and (2) examine whether potential differences are explained by socioeconomic factors.

Methods

The Coronary Artery Risk Development in Young Adults (CARDIA) study, a biethnic, prospective, multicenter epidemiologic study of the evolution of risk factors in young adults, has been described in detail elsewhere.[19] Briefly, from 1985 to 1986, 5115 African American and White individuals aged 18 to 30 years were examined in Birmingham, Ala; Chicago, Ill; Minneapolis, Minn; and Oakland, Calif. At the Birmingham, Minneapolis, and Chicago sites, participants were randomly selected from total communities or from specific census tracts. In Oakland, participants were randomly selected from members of the Kaiser Permanente medical care program.

Recruitment was stratified to achieve nearly equal numbers at each site in terms of race (African American, White), sex, education (high school or less, more than high school), and age (18–24 years, 25–30 years). Fifty percent of individuals contacted were examined (47% of African Americans and 60% of Whites) and became the CARDIA cohort.

The authors, with the exception of Lynne E. Wagenknecht, are with the Department of Medicine, University of Alabama at Birmingham. Lynne E. Wagenknecht is with the Department of Public Health Sciences, Wake Forest University School of Medicine, Winston-Salem, NC.

Requests for reprints should be sent to Catarina I. Kiefe, PhD, MD, University of Alabama at Birmingham, 1717 11th Ave S, MT 700, Birmingham, AL 35205-4785 (e-mail: ckiefe@uab.edu).

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Among Whites, 39% of nonparticipants smoked (as compared with 29% of participants; $P<.001$); among African Americans, however, smoking prevalence rates in participants and nonparticipants were similar (33% vs 31%; $P=.13$).[20]

Participants were recontacted annually and reexamined in year 2 (1987–1988), year 5 (1990–1991), year 7 (1993–1994), and year 10 (1995–1996). Of the 5115 initial participants, 84 had died by year 10, and 3950 (79% of survivors) were reexamined at year 10. Follow-up rates were 91%, 85%, 80%, and 79% in years 2, 5, 7, and 10, respectively.

Data Collection

All 3950 individuals examined at both baseline and year 10 were included in this report. Data collected on additional participants not reexamined at year 10 are also reported in some subanalyses. Included are data on smoking status, demographic characteristics, and socioeconomic factors.

Smoking status was ascertained at all years via an interviewer-administered questionnaire. Participants who reported regular cigarette smoking (at least 5 cigarettes per week almost every week for at least 3 months) at the time of a CARDIA examination were classified as regular smokers at that examination. Individuals who were not regular smokers are designated as nonsmokers for brevity. Thus, nonsmokers might be never, former, or occasional smokers. Self-report of cigarette smoking was validated at baseline against a biochemical marker of nicotine uptake, serum cotinine, and misclassification was found to be low (1.3% underreporting overall).[21]

Sociodemographic factors included age, sex, race, years of education, family income, employment status, marital status, difficulty paying for basic necessities, home ownership, and health insurance status. These data were collected from all participants at most examinations, but income and home ownership were not ascertained at baseline and year 2, health insurance status was ascertained at years 7 and 10 only, and difficulty paying for basic needs was queried at all examinations except year 5.

Annual family income was ascertained as an ordinal variable with 8 categories ranging from less than $5000 to $75 000 or more. We collapsed these 8 categories into 3: less than $25 000, $25 000 to $49 999, and $50 000 or more. Difficulty paying for basic needs was queried as follows: "How hard is it for you (and your family) to pay for the very basics like food, medical care, and heating?" This item was scored as an ordinal variable with 4 categories, dichotomized for analytic purposes.

Home ownership was established if participants stated that their home was owned or being bought by them or someone in the household. In regard to health insurance status, we asked "In the past 2 years, have you always had health insurance or other coverage for medical care?"

Employment status was queried as follows: "Since your last CARDIA examination, have you been unemployed and looking for work for more than 2 months?" Marital status was reflected in 6 categories and collapsed into 2: married and not married. All data collection personnel were trained and certified centrally and were subsequently recertified in individual field centers according to the CARDIA manual of operations.[22]

Data Analysis

Two individuals who had undergone surgical sex change since the baseline assessment were excluded from race/sex-specific analyses. Because our definition of regular smokers excludes those smoking only occasionally, we denote individuals who moved from nonregular smoking status at baseline to regular smoking status at follow-up as *regular* smoking initiators. Prevalence of smoking at each examination was defined as the proportion of participants examined who were regular smokers at that examination.

We computed regular smoking initiation (cessation) rates for years 2, 5, 7 and 10 by calculating the proportion of baseline nonsmokers (smokers) who were regular smokers (nonsmokers) at years 2, 5, 7, and 10, respectively. Thus, an individual might be classified as an initiator in spite of a remote previous history of smoking (e.g., if the individual had been a former smoker at baseline). Chi-square and *t* tests were used as appropriate to examine associations between 10-year changes in smoking and socioeconomic factors.[23]

We then adjusted bivariate associations between race and 10-year change in smoking status for socioeconomic factors using multiple logistic regression; regular smoking cessation and regular smoking initiation were dependent variables, and race was the main independent variable. Initially, only baseline and year 10 data were used in multiple logistic regression models. Separate models for men and women were developed. We examined interactions between race and socioeconomic factors but included these interactions in the models only if they were statistically significant ($P<.10$).

TABLE 1—Regular Smoking Prevalence at Baseline and Year 10 and Selected Sociodemographic Characteristics for All Participants Examined at Both Years, by Race/Sex Group: CARDIA Study, 1985–1996

	Baseline				Year 10			
	Women		Men		Women		Men	
	African American	White	African American	White	African American	White	African American	White
No.	1120	1072	806	950	1120	1072	806	950
Smoking prevalence, %								
Overall	30.4	25.2	35.4	24.3	27.7	18.9	37.4	20.6
Birmingham	21.8	29.3	31.5	32.7	18.8	21.0	35.3	23.6
Chicago	29.7	28.8	39.3	21.0	27.2	22.8	38.9	13.6
Minneapolis	43.3	32.4	52.1	33.0	39.2	22.0	50.3	27.7
Oakland	31.6	18.4	26.6	16.1	28.1	13.6	27.1	11.0
Mean age, y	24.5	25.6	24.3	25.5	34.5	35.6	34.3	35.5
Mean education, y	13.2	14.6	13.0	14.7	13.8	15.5	13.5	15.5
Not married, %	79.0	71.3	81.8	76.8	63.8	40.3	59.1	42.9
Not fully employed, %	52.7	38.6	45.0	30.5	32.2	36.7	22.9	12.2
No medical insurance, %	. . .[a]	. . .[a]	. . .[a]	. . .[a]	16.8	11.5	23.0	15.2
Difficulty paying for basic needs, %	38.0	36.0	31.8	26.7	41.5	23.2	27.7	15.1
Own home, %	. . .[a]	. . .[a]	. . .[a]	. . .[a]	45.4	68.1	43.3	66.7

Note. Denominators may vary slightly across rows owing to missing variables.
[a]Not available.

To better understand possible racial differences in the impact of education and income on smoking behavior, we also developed multiple logistic regression models for each of the 4 race/sex groups separately. Initially, we included in the models dummy variables for sites to account for potential differences across sites. However, because the coefficients for sites were not significant (at $P<.10$), we removed them from the models.

We used year 10 socioeconomic factors in the multiple logistic regression models, because all factors of interest had been collected at year 10 but not at all previous years. However, to determine whether possible changes in socioeconomic factors from previous years to year 10 might have changed our conclusions, we repeated these multivariable analyses in 2 ways: (1) we modeled 10-year initiation/cessation rates, using socioeconomic factors collected at baseline (education, marital and employment status, and difficulty paying for basic needs), and (2) we modeled 5-year habit initiation/cessation rates (i.e., changes in smoking status between years 5 and 10), using as covariates socioeconomic factors collected at year 5 (education; marital, employment, and home ownership status; and income).

Results

Among both men and women, smoking prevalence rates were lower for Whites than for African Americans at baseline, with racial differences increasing by year 10 (Table 1). Although baseline smoking prevalence rates varied markedly across sites, 10-year changes in prevalence were consistently more beneficial for Whites than for African Americans at each site and for each sex (Table 1). Overall, in comparison with Whites, African Americans had less education, were less frequently married or fully employed, and had more difficulty paying for basic needs at both baseline and year 10 (Table 1).

By year 10, African American women who were nonsmokers at baseline were about twice as likely to have started regular smoking as White women (7.1% vs 3.5%); this ratio was even higher for men (13.2% vs 5.1%; Table 2). Among both men and women, smoking cessation rates were higher for Whites than for African Americans. Socioeconomic disparities by ethnicity observed overall (Table 1) were also present within initiating or quitting groups, with African Americans consistently being of lower SES (Table 2). Within race/sex groups, initiators tended to be of lower SES than quitters (Table 2).

Figure 1 compares crude and adjusted odds ratios for the association between race and 10-year regular smoking initiation and cessation rates. Table 3 presents the full multiple logistic regression models that yielded the adjusted odds ratios shown in Figure 1. Among women, racial differences in year 10 regular smoking initiation and cessation rates were not significant after adjustment for socioeconomic factors. This result also held for smoking cessation among men, but the adjusted odds ratio for regular smoking initiation among African American men vs White men was 1.65 ($P=.04$). Adding interaction terms to the models suggested a stronger association of education and smoking among Whites than among African Americans and eliminated completely the statistical significance of the race effects in the regular smoking initiation model for men. The interaction terms were not statistically significant, however ($P>.12$; data not shown).

Although interaction terms were not significant, the models suggested that education and income might have different associations in African Americans than in Whites, so we also developed separate multiple logistic regression models for each race/sex group (data not shown). Education level was consistently associated with regular smoking initiation in all groups except African American men and was associated with cessation in White men and women. Low income, on the other hand, was a powerful predictor of regular smoking initiation in African American men but not in the other 3 groups, while smoking cessation was associated with high incomes among White men and women but not among African Americans.

Adjusting 10-year regular smoking initiation/cessation rates for baseline socioeconomic factors and adjusting 5-year rates (changes from year 5 to year 10) for year 5 socioeconomic factors again showed that only regular smoking initiation in men might still be associated with race after socioeconomic factors were taken into account (data not shown). Multiple logistic regression models in which baseline and year 10 prevalence rates of smoking were adjusted for socioeconomic factors also rendered racial differences nonsignificant (data not shown).

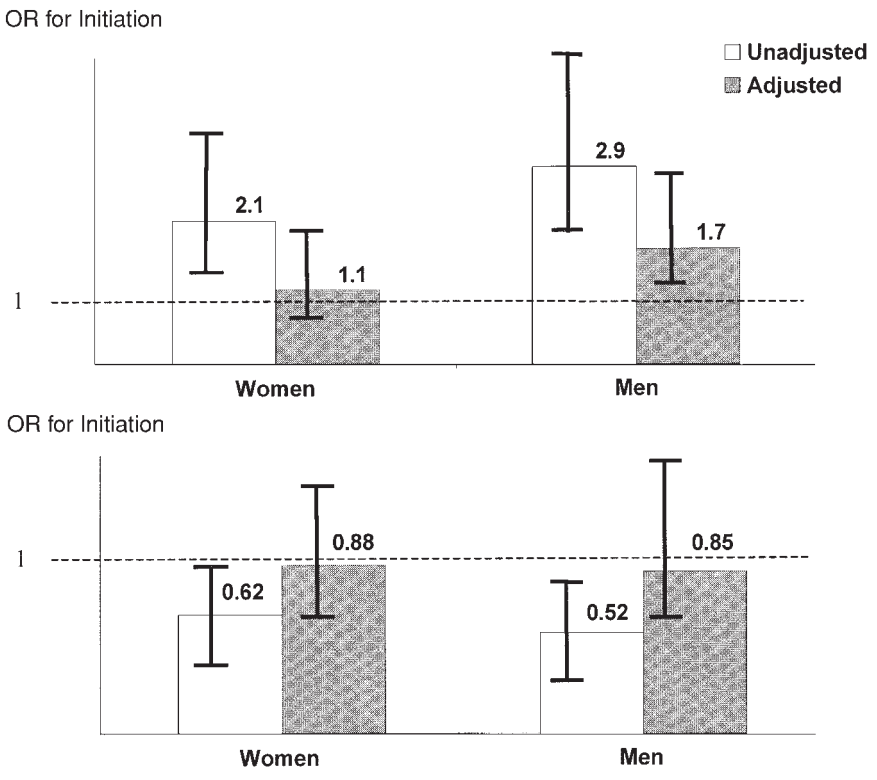
Discussion

In the CARDIA cohort, African American women and men had markedly higher smoking prevalence rates, as well as higher 10-year regular smoking initiation rates and lower 10-year cessation rates, than their White counterparts. The 10-year regular smoking initiation rate of 13.2% observed among African American men is strikingly high, especially in comparison with the 5.1% initiation rate observed among White men. However, after adjustment for socioeconomic factors, racial differences were no longer statistically significant, with the possible exception of regular smoking initiation rates among African American men, which in some models remained higher than those for White men.

TABLE 2—Ten-Year Regular Smoking Initiation and Cessation Rates and Socioeconomic Characteristics of Regular Initiators and Quitters at Year 10, by Race/Sex: CARDIA Study, 1985–1996

	Initiators				Quitters			
	Women		Men		Women		Men	
	African American	White	African American	White	African American	White	African American	White
10-year initiation[a] or cessation[b] rate	7.1	3.5	13.2	5.1	25.0	35.1	19.2	31.3
Mean education, y	13.3**	14.8	13.4	14.1	13.4**	15.0	13.0**	14.9
Income <$25 000, %	57.4*	21.4	60.0**	14.7	46.3**	16.3	35.2**	9.9
Married, %	16.4*	46.4	27.3	38.9	34.2**	71.7**	0.0	63.4
Not fully employed, %	38.2	35.7	33.3	30.6	46.3	46.7	22.2	12.7
No health insurance, %	25.9***	3.6	34.9***	22.2	12.2	12.0	14.8	19.7
Difficulty paying for basic needs, %	49.1	39.3	28.8	16.7	41.5	29.4	29.6	15.5
Own home, %	36.4*	71.4	27.3	44.4	43.9*	67.4	37.0**	70.4

*$P<.01$; **$P<.001$; ***$P<.005$ (African American vs White).
[a]10-year regular initiation rate: percentage of baseline nonsmokers or nonregular smokers who smoked regularly at year 10.
[b]10-year cessation rate: percentage of baseline regular smokers who were not regular smokers at year 10.



Note. Adjustments were made for socioeconomic factors (see Methods section).

FIGURE 1—Adjusted and unadjusted odds ratios (ORs) and 95% confidence intervals for regular smoking initiation and cessation over 10 years in African Americans vs Whites: 3950 participants in the CARDIA study examined in 1985–1986 and again in 1995–1996.

Cigarette smoking has been related to education level in many cross-sectional studies.[3,20] For example, data from the National Health Interview Survey show that low educational attainment accounts for a substantial portion of the Black–White differences in smoking prevalence.[24] Our finding that racial differences in changes in smoking behavior are almost completely explained by socioeconomic factors is new. This may be so because epidemiologic studies of smoking cessation and initiation tend to rely on data collected cross sectionally, with consequent limitations.[20,24–29]

Most previously published studies of smoking cessation or initiation have been based either on sequential cross-sectional prevalence data or on retrospective data on past smoking habits collected cross sectionally, thus rendering adjustment for potential confounders at the individual level more problematic owing to, among other issues, recall bias. CARDIA offered a unique opportunity to follow smoking habits for a cohort prospectively over a 10-year period.

In our longitudinal study, Black–White differences in regular smoking initiation among women were statistically nonsignificant after adjustment. In men, the association was markedly attenuated but remained statistically significant in some of the models. Why this sex difference? Clearly, our indicators of SES were crude and unlikely to capture fully this complex construct. Thus, there may be residual confounding by SES in the association between race and regular smoking initiation among men, even after adjustment for our indicators.[30,31] Perhaps our imperfect measures of SES were less imperfect in women. Alternatively, consequences of race- and culture-related phenomena, such as racial discrimination, may manifest differently along sex lines, and there may be an effect of race on smoking behavior independent of SES in our culture for men but not for women.

Beneficial changes in smoking behavior were strongly and positively associated with higher educational attainment, among men as well as women and independently of all other measured socioeconomic factors. In our race/sex-specific analyses, we observed interesting racial contrasts in the relative impact of income and education on smoking behavior, with income appearing to be a stronger predictor of beneficial smoking changes among African American men than among White men. Why this differential impact? When racial comparisons of family wealth are made after stratification by family income, it becomes clear that, at similar income levels, African Americans have dramatically fewer material resources than Whites.[32] Thus, low income may be a marker of economic deprivation that is more profound for African Americans than for Whites.[30] Similarly, at equal levels of educational attainment, income is lower for African Americans than for Whites,[33] suggesting that the value of education as an index of SES may differ by ethnicity.[34]

What might be the practical implications of emphasizing SES rather than race/ethnicity as a determinant of smoking status? The 1998 surgeon general's report cites the need for culturally sensitive programs directed against smoking.[13] As others have asked,[35] is the development of such ethnically and culturally targeted programs the best way to spend limited public health resources? If racial differences disappear once socioeconomic factors are fully taken into account, should we not rather direct our efforts to reduce socioeconomic inequalities in, say, education or access to health care?[36,37] Culturally targeted programs are efficacious and may be easier to implement than profound changes in education or access, but the limitations of such programs, absent these more profound changes, need to be clearly recognized.

Although CARDIA's 10-year retention rate of 79% is excellent given its mobile, biethnic cohort of young adults, nonsmokers in higher SES groups were retained selectively. How might this have biased our results? CARDIA's baseline response rate of 50% included preferential selection of nonsmokers among Whites but not among African Americans. Also, CARDIA retention rates were higher for nonsmokers than for smokers, but the difference was more pronounced for Whites than for African Americans. This suggests that, among CARDIA participants examined at year 10, nonsmokers were overrepresented in both ethnic groups but more so for Whites than for African Americans. Because African Americans have higher smoking prevalence rates, one might then infer that response and retention biases in CARDIA would have accentuated differences in smoking status (i.e., ethnic differences observed in CARDIA would have been somewhat higher than in the underlying population). If anything, this would strengthen our key conclusion that racial differences are less pronounced than what the unadjusted data suggest.

In another CARDIA investigation of 10-year changes in smoking, Wagenknecht et al.[38]

TABLE 3—Adjusted Odds Ratios for 10-Year Regular Smoking Initiation and Cessation Among Women and Men: CARDIA Study, 1985–1996

	Women		Men	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Initiation				
African American (vs White)	1.14	0.67, 1.95	1.65	1.03, 2.68
1-year increment in age	0.99	0.94, 1.06	1.00	0.94, 1.06
1-year increment in education	0.82	0.73, 0.92	0.86	0.77, 0.95
Income (vs > $50 000)				
< $25 000	0.93	0.43, 2.03	2.96	1.41, 6.41
$25 000–$50 000	0.71	0.36, 1.40	1.94	1.03, 3.78
Not married (vs married)	2.56	1.45, 4.68	1.27	0.78, 2.09
Not fully employed (vs fully employed)	1.20	0.60, 2.25	1.93	0.97, 3.67
No health insurance	0.88	0.53, 1.46	1.33	0.77, 2.23
Difficulty paying for basic needs	1.84	1.09, 3.10	0.66	0.37, 1.14
Not home owner	0.88	0.53, 1.46	1.78	1.11, 2.91
Cessation				
African American (vs White)	0.88	0.59, 1.32	0.85	0.53, 1.37
1-year increment in age	1.01	0.96, 1.07	0.98	0.92, 1.04
1-year increment in education	1.19	1.09, 1.31	1.18	1.07, 1.30
Income (vs > $50 000)				
< $25 000	1.01	0.54, 1.91	0.73	0.35, 1.53
$25 000–$50 000	1.05	0.64, 1.73	1.33	0.76, 2.33
Not married (vs married)	0.53	0.35, 0.82	0.66	0.41, 1.08
Not fully employed (vs fully employed)	1.26	0.76, 2.09	0.64	0.29, 1.31
No health insurance	0.67	0.37, 1.14	0.63	0.35, 1.10
Difficulty paying for basic needs	0.86	0.56, 1.31	0.83	0.48, 1.39
Not home owner	1.03	0.66, 1.62	1.14	0.70, 1.86

Note. Four separate models were used, for women and for men for initiation and cessation. Socioeconomic factors were measured at year 10. See Methods section for definition of variables. Model *C* statistics for women and men, respectively: initiation, 0.72 and 0.76, and cessation, 0.75 and 0.73.

used a weighted[39] generalized estimation equation approach[40] to model annual changes in smoking prevalence rates as a function of time. Analyses were performed separately on each of the 4 race/sex groups. We did not use this approach because we were primarily interested in cumulative 10-year cessation/initiation rates. Nonetheless, the weighted generalized estimation equation approach provided estimates of prevalence that were not biased by the differential response rates (J. S. Preisser, K. K. Lohman, T. E. Craven, and L. E. Wagenknecht, unpublished data, 1998).[40] In these analyses, which were not adjusted for socioeconomic factors, smoking prevalence declined in White men and women, remained stable in African American women, and increased in African American men. It is encouraging that weighted generalized estimation equation analyses adjusting for differential retention rates (albeit unadjusted for socioeconomic factors and focusing on prevalence rather than cessation and initiation) are consistent with the racial contrasts we observed.

Beyond the potential limitations in generalizability arising from response and retention biases, there is also the issue that the CARDIA cohort represents 2 racial/ethnic groups and 4 urban areas only. Therefore, our results may not apply to, for example, rural areas or racial/ethnic minorities other than African Americans. Furthermore, although we had information on multiple socioeconomic factors, each of these factors is limited in its definition of SES. Conceptualization of SES is complex, and there is no "gold standard" for its measurement.[41,42] We included several of the most common markers of SES used in epidemiologic studies, namely education, income, employment, and marital status.

A final limitation is that CARDIA was designed in the early 1980s, and hence we were unable to capture separately occasional smoking, an issue that has since become increasingly recognized as important.[43] However, the main focus of our study was not a refined analysis of changes in smoking behavior per se but, rather, an analysis of whether or not observed racial differences in smoking changes could be explained by socioeconomic factors.

In summary, in our urban cohort of young adults, African Americans had higher prevalence rates, higher regular smoking initiation rates, and lower cessation rates than Whites over a 10-year period. However, these differences were largely explained by differences in socioeconomic factors. Therefore, public health efforts aimed at changing smoking behavior need to give high priority to addressing socioeconomic inequalities. □

Contributors

C. I. Kiefe planned the study, planned the analyses, and wrote most of the paper. O. D. Williams contributed to the planning, analyses, and writing. C. E. Lewis contributed to the planning and writing. J. J. Allison contributed to the discussion on racial disparities and the writing of the paper. P. Sekar performed the analyses and contributed to the writing of the paper. L. E. Wagenknecht contributed to the discussion of the epidemiology of smoking and the writing of the paper.

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